Chesapeake Lighthouse and Aircraft Measurements for Satellites (CLAMS)

OVERVIEW

CLAMS is the Chesapeake Lighthouse and Aircraft Measurements for Satellites field campaign sponsored by CERES, MISR, MODIS-Atmospheres and the NASA/GEWEX Global Aerosol Climatology Project (GACP). The centerpiece of CLAMS is the Chesapeake Lighthouse sea platform 20 km east of Virginia Beach, at which NASA and NOAA make continuous, long-term measurements of radiation, meteorology, and ocean waves. Members of the CERES, MISR and MODIS instrument teams are collaborating to accomplish a common set of objectives tied to the validation of EOS data products. A first CLAMS campaign, currently being planned for July 2001 to validate Terra data products, is a shortwave closure experiment targeting clear (cloud-free) sky conditions and focused on obtaining

- more accurate spectral and broadband radiative fluxes at the surface and within the atmosphere
- characterization of ocean optics in the vicinity of the lighthouse
- description of the atmospheric aerosol amounts, micro-physical and optical properties, and their variability

The observation strategy being designed for CLAMS to accomplish these goals will help satisfy a more specific set of objectives which includes

Validating retrievals of aerosol properties from satellites

- comparisons with in-situ measurements, surface-based measurements, and sensor intercomparisons
- assessing the impact of scene variability on measurement uncertainty, on 10 meter to 10 kilometer spatial scales
- testing the impact of improved boundary specification using CLAMS measurements
- improving retrievals in sunglint regions

A more accurate description of the shortwave radiation budget of the cloud-free earth-atmosphere system

- improved characterization of ocean optics including BRDF as a function of sun angle, aerosol loading, wind and sea state
- assessing the radiative impacts of aerosols
- extending the interpretation of CLAMS data to the open ocean

A second and similar campaign is being considered for 2002 for Aqua data product validation with additional focus in the longwave and on atmospheric water vapor.

AIRCRAFT

The July 2001 CLAMS will include a low-level aircraft, the NASA Langley OV-10, to measure radiation at the sea surface and a high-altitude research aircraft, the NASA ER-2, to measure radiation and sense aerosols remotely with lidar. CERES supports the OV-10 and the ER-2 is being supported by MISR, MODIS-Atmosphere and the EOS Airborne Special Fund. 20 (12) hours of ER-2 flight time have been approved for CLAMS to satisfy MODIS-Atmosphere (MISR) objectives. A third aircraft, the University of Washington Convair-580 is available and highly desirable to profile aerosol properties in situ. The fiscal support of the Convair-580 has not yet been secured. NASA AMES Solar Spectral Flux Radiometer (SSFR) and a sun-tracking photometer (AATS) are also desirable for the CV-580 but have not yet been committed. The OV-10 would likely fly whenever any of the other aircraft were flying. Table 1 lists the aircraft and key instruments likely for CLAMS. A more detailed description of the sampling strategy for CLAMS aircraft is forthcoming.

SURFACE INSTRUMENTATION

The focal point of CLAMS measurement campaign is the CERES Ocean Validation Experiment (COVE) site at the Chesapeake Lighthouse - a rigid sea platform 20 km east of Virginia Beach at 36.9 N and 75.71 W. The water depth at COVE is 11 m. NASA LaRC has a 20 year agreement with the United States Coast Guard for continuous access to this platform. Support for the extensive instrumentation package that will be deployed at COVE during CLAMS is primarily through CERES and the GACP. Most of the instrumentation is deployed 15-25 m above the sea surface, well above the most intense ocean spray. Nevertheless, routine trips to the lighthouse by COVE scientists and support personnel and the engagement of an autonomous spray washing system are required to keep the instrument domes clean and maintain the integrity of the data. CERES has installed and maintains a BSRN measurement station at COVE since August 1999 for broadband fluxes, supplemented with an MFRSR photometer for spectral aerosol optical thickness. GSFC installed an AERONET (Cimel) sunphotometer on the platform in October, 1999. A SP1A spectralphotometer at COVE scans downward to measure the reflected radiation by the sea, an important boundary condition for satellite remote sensing. Additionally, numerous other radiometers have been or are being installed at COVE including Eppley pyranometers specially modified to account for thermal offset phenomena, Kipp & Zonen radiometers, pyrgeometers, shadowband radiometers, a shortwave spectrometer and an MPLnet micro pulse lidar. A compliment of in-situ oceanographic instruments may be deployed by Dr. Glenn Cota from the Old Dominion University (ODU) Ocean, Earth and Atmospheric Sciences Department. Dr. Se-Chee Tsay (GSFC) intends to deploy his SMART network at COVE or a nearby coastal location. Table 2 lists the instrumentation expected to be fully operational at COVE for CLAMS and the person or organization responsible for the instruments deployment including the data reduction, analysis and submission for archival.

MISSION OPERATIONS

CLAMS will be conducted primarily in the vicinity of the Chesapeake Lighthouse Platform, approximately 20 km East of Virginia Beach. Ideally, the participating scientists, forecaster(s) and support personnel will deploy to a common location. At this early stage, it appears that Wallops Island would be the best location since the ER-2 will deploy from Wallops as will the CV-580 if it participates. The OV-10 can also deploy from Wallops. We are checking to confirm that the appropriate fuel, power services, hangar space and laboratory space will be available to support CLAMS. Table 3 provides a preliminary breakdown of science objectives and flight hours for CLAMS. A more detailed operations

plan is forthcoming.

ORGANIZATION

Project Management

The CLAMS project activities will be managed at NASA Langley Research Center (LaRC). Mr. William Smith has been appointed the Lead Mission Scientist. Mr. Smith will be responsible for coordinating the planning and implementation of the science objectives, conduct planning and debriefing sessions and be the chief representative of and arbitrator for the participants during the field campaign. Mr. Victor Delnore will serve as the CLAMS Program Coordinator. Mr. Delnore will provide logistical support in planning and conducting the field campaign and associated meetings. CLAMS Project Scientists have been identified to serve as the lead representatives for their respective teams. They are Dr. Tom Charlock for CERES and GACP, Dr. Lorraine Remer and Dr. Jose Vanderlei Martins for MODIS-Atmospheres and Dr. Ralph Kahn for MISR. Table 4 identifies the key personnel for CLAMS to date.

Data Policy

The CLAMS data policies proposed are based on open data sharing, cooperation and synergism and follow the SAFARI 2000 policy. A data policy will be implemented to ensure that participants have access to data in a timely manner and that appropriate protection of intellectual property rights is ensured and that co-authorship, acknowledgement or credit are given to data originators and principal investigators. Two sources formed the basis for the recommendation of the CLAMS data policy, viz. (i) the International Scientific Unionís policy on open data and data sharing, and (ii) NASAís EOS Validation Program data policy which stipulates that principle investigators submit preliminary results within 6 to 12 months from the date of measurement. A complete data policy is forthcoming.

CLAMS Web Site

The official CLAMS web site can be found at http://www-cave.larc.nasa.gov/cave/ by clicking "CLAMS".

Table 1. Aircraft platforms and key instruments for CLAMS. (*) indicates platform or instrument not yet committed.

Platform/Instruments	Investigator/Institution
OV-10	
Eppley Broadband LW and SW upwelling and downwelling fluxes	Smith, Larman, Roback / LaRC
ASD Fieldspec upwelling and downwelling SW spectral irradiance/radiance from 300-2500 nm at 3-10 nm resolution	
IR Radiometer for skin temperature	
Meteorology (T, P, Td)	
NASA ER-2	
MAS	Martins, Remer/GSFC
AirMISR	Kahn/JPL
Cloud Physics Lidar (CPL)	Spinhirne, McGill/GSFC
AVIRIS	TBD
(*) Univ. of Wash. Convair-580	Hobbs/U. of Washington
Eppley Broadband LW and SW upwelling and downwelling fluxes	
Omega IR Radiometer for skin temperature	
TSI APS, PMS FSSPís , PMS PCASP, PSAP, nepholometer(s) for aerosol measurements	
Meteorology (T, P, Td, U, V)	
(*) NASA AMES SSFR upwelling and downwelling SW spectral irradiance/radiance from 300-2500 nm at 5-10 nm resolution	Pilewskie/NASA AMES
(*) NASA AMES AATS suntracking photometer	Russell/NASA AMES

Table 2. Surface Instrumentation at COVE for CLAMS

Observations	Instruments	Investigator/Institution
Radiation and Aerosols		
Broadband fluxes, albedo	Solar and IR radiometers	
	• Eppley (BSRN)	Rutledge/LaRC
	• Modified Epplyís	Haeffelin/LaRC
	• Kipp & Zonen	Rutledge/LaRC
Spectral solar, direct, diffuse, and aerosol optical thickness	ASD FieldSpec	Rutledge/LaRC
	Sun Photometers	Su, Charlock/LaRC
	-Schultz	AERONET/GSFC
	-Cimel	Denn/LaRC
	Shadowbands	
	-MFRSR, TDDR	
	SMART network (location TBD)	Tsay/GSFC
Aerosols (vertical profile)	CPL	McGill, Spinhirne/GSFC
Ocean Parameters		
Incident up, down, subsurface spectral radiance, irradiance	Satlantic SMSR, SPMR	Cota/ODU
Spectral absorption, attenuation	WET Labs AC-9 (2x)	
Spectral backscatter	HOBI Labs HS-6	
Chlorophyll a & phaeophytin	Turner Design flourometer	
CDOM, particulate and phy-toplankton abs. spectra	Shimadzu 2401	
Particle size spectra	Elzone	
WATER LEAVING RADIANCE	Schultz sunphotometer	Su, Charlock/LaRC
Sea surface slope	Laser optical detector	Shaw/NOAA
Wave activity	IR wave sensor (standard)	NOAA
Meteorology		
Surface (T, P, RH, U, V)	NOAA standard met.	NOAA
Profiles (T, P, RH)	Rawinsondes (Vaisala)	Maddigan/LaRC
Integrated water vapor	GPS	Maddigan/LaRC
Other	Whole sky, sea cameras	Larman/LaRC

Table 3. Preliminary breakdown of science objectives and flight hours for CLAMS.

Sponsor	Objective	Hours	Location	Platforms	Key Instruments
MODIS	Validation of aerosol retrievals in cloud-free and mainly partly cloudy conditions	10	50% around COVE site and open ocean 50% over coastal regions	ER-2, OV-10	MAS, CPL, AirMISR, AVIRIS, COVE aerosol retrievals, Field-spec FR
MODIS/ CERES	Validation of retrievals over glint areas	6	COVE site and open ocean	ER-2, CV-580, OV10	MAS, AirMISR
MODIS/ CERES	Complex aerosol verti-cal structures	4	COVE site and open ocean	ER-2, CV-580, OV-10	MAS, CPL, AirMISR, AVIRIS, COVE aerosol retrievals, cameras.
MISR/ CERES	Cloud-free SW closure experiment	6	COVE site	ER-2, CV-580, OV-10	ALL
MISR	Cloud-free spatial vari-ability study	6	COVE site	ER-2, CV-580, OV-10	ALL
CERES	Ocean BRDF	8	COVE site and open ocean	CV-580	CAR

Table 4. CLAMS participants identified to date.

Name	Organization	Platform	Representation
Bill Smith Jr.	LARC	OV-10	Lead Mission Scientist
Tom Charlock	LaRC	COVE	CERES/GACP Liason
Ralph Kahn	JPL	ER-2	ER-2 Co-Mission Scientist/MISR Liason
Lorraine Remer	GSFC	ER-2	ER-2 Co-Mission Scientist/MODIS Liason
Vanderlei Martins	GSFC	ER-2	ER-2 Co-Mission Scientist/MODIS Liason
TBD	TBD	ER-2	AVIRIS Liason
Vic Delnore	LARC	COVE	Program Coordinator
Ken Rutledge	LARC	COVE	COVE Mission Scientist
Michael King	GSFC	ER-2/CV-580	MODIS/CAR Liason
Jason Li	GSFC	CV-580	CAR Liason
Louis Nguyen	LaRC	OV-10	Satellite Coordinator
David Rutan	LaRC/AS&M	COVE	CLAMS Web Curator
Fred Rose	LaRC/AS&M	COVE	Mission Forecaster
Glenn Cota	ODU	COVE	Oceanographic Liason
Jim Spinhirne	GSFC	ER-2	CPL Liason
Matt McGill	GSFC	ER-2	CPL Liason
Si-Chee Tsay	GSFC	COVE	SMART Liason
Peter Hobbs	U. Washington	CV-580	CV-580 Mission Scientist